TERMA UPDATE . JUNE 2005

update

Missile Warner System Integration

In this Update issue

The Royal Danish Air Force (RDAF) and Terma are breaking new ground with an integrated self-protection suite for the F-16.

The RDAF and Terma have developed the concept for a Missile Warner System (MWS) suite integration which uses the full potential of the MWS and the available aircraft data to enable the pilot to react as fast as possible to a missile attack. The input from the MWS is fused with the aircraft data and presented to the pilot as 3D-audio as well as graphically on a color Advanced Threat Display, both systems developed by Terma. The MWS is installed in the Wing Weapon Pylons. Read more on pages 2-3.

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TERMA

Why Integrate a Missile Warner System on a Fighter?

In some areas, the full potential of the F-16 is not being used today because especially IR threats have developed more rapidly than self-protection systems. The only realistic solution is a very capable Missile Warner System which interfaces with an advanced EW controller – such as the Terma AN/ALQ-213 (V) EW Management System.

The F-16 was originally developed as a multi-role fighter and many of its capabilities have been dramatically improved.

When the F-16 was developed in the late 1970s, the threat from man-portable IR missiles was almost non-existent. The F-16 could therefore operate in all altitudes with its RF self-protection systems operating. During the 1980s, the small man-portable IR seeking missiles became available – also on the black market. As a "worst case scenario", the man-portable missiles could now be anywhere. This, in turn, has an adverse impact on low level operations.

The IR missiles can be decoyed by flares, but to detect them from a fast moving fighter, you need a very capable Missile Warner System (MWS). The flight time for a missile is typically 5-7 seconds so in that timeframe you need to detect and decoy the missile – including maneuvering.

F-16 MWS Integration Contract

Not least to support international operations including take-off and landing from non-secure airfields, the Royal Danish Air Force (RDAF) needed a full and safe operational envelope for their F-16. To support this requirement, a modern MWS was needed and a contract was awarded to EADS to deliver a fast jet version of their MILDS system, designated AAR-60(V)2. The upgrade of the MILDS system includes a repackaging of the sensors and an addition of a Countermeasures Signal Processor (CSP) which Terma is developing and manufacturing.

The selection of the MWS was a very important step for the RDAF, but to secure an integrated solution which provides maximum survivability for the crew and aircraft, several additional tasks were required.

- The MWS had to be installed in a cost effective way on the aircraft.
- The MWS had to be integrated in the current EW suite.
- Due to a very critical time aspect, the pilot had to be alerted instantaneously with a very precise indication of the incoming missile.

All these tasks were contracted by the RDAF to Terma in late 2004.

MWS Pylon Integration

To secure the cost effective installation of the MWS, an installation in the Wing Weapon Pylon was selected.

The F-16s are equipped with MWS, Aircraft Audio Management Systems, and an Advanced Threat Display

The MWS is installed
in the Wing Weapon Pylon

The concept has several advantages:

- Both the non-recurring and recurring cost of integrating the MWS in a pylon is only a fraction of the cost of modifying the airframe.
- The pylons may be moved between aircraft.
- The sensors have been installed to secure optimum coverage where a missile attack is most lethal.
- The F-16 MLU M3 aircraft are being fitted with provisions for the pylon solution so the integration costs are truly minimized.

Aircraft Audio Management System

The pilot must be provided with fast, reliable, and very accurate information about the missile attack so he can decoy the missile. The Terma AN/ALQ-213(V) will select the optimum flare dispense program, based on threat data and aircraft situation, but to aid the flare dispense, a coordinated maneuvering has to be performed and this has to be initiated immediately and relative to the flight path of the missile.

This situation was realized several years ago by Terma and the RDAF and a concept to equip the aircraft with a 3D-audio system was launched. The 3D-audio system processes all audio input before it is sent to the pilot. The basic processing system transforms, by means of advanced algorithms, standard audio input into 3D-audio which the listener perceives as coming from a distinct direction and range.

Terma's "Aircraft Audio Management System" (AAMS) can process all the data into a precise audio input into the pilot's headset which enables the pilot to react and maneuver intuitively – and thus faster to the threat.

It is not only MWS information which is being enhanced, Radar Warner threats are processed similarly. Other information such as radio communication from another aircraft or tower can also be presented in the applicable direction.

The Terma AAMS also includes an "Active Noise Reduction" system which lowers the noise level perceived by the pilot and thus reduces the fatigue impact.

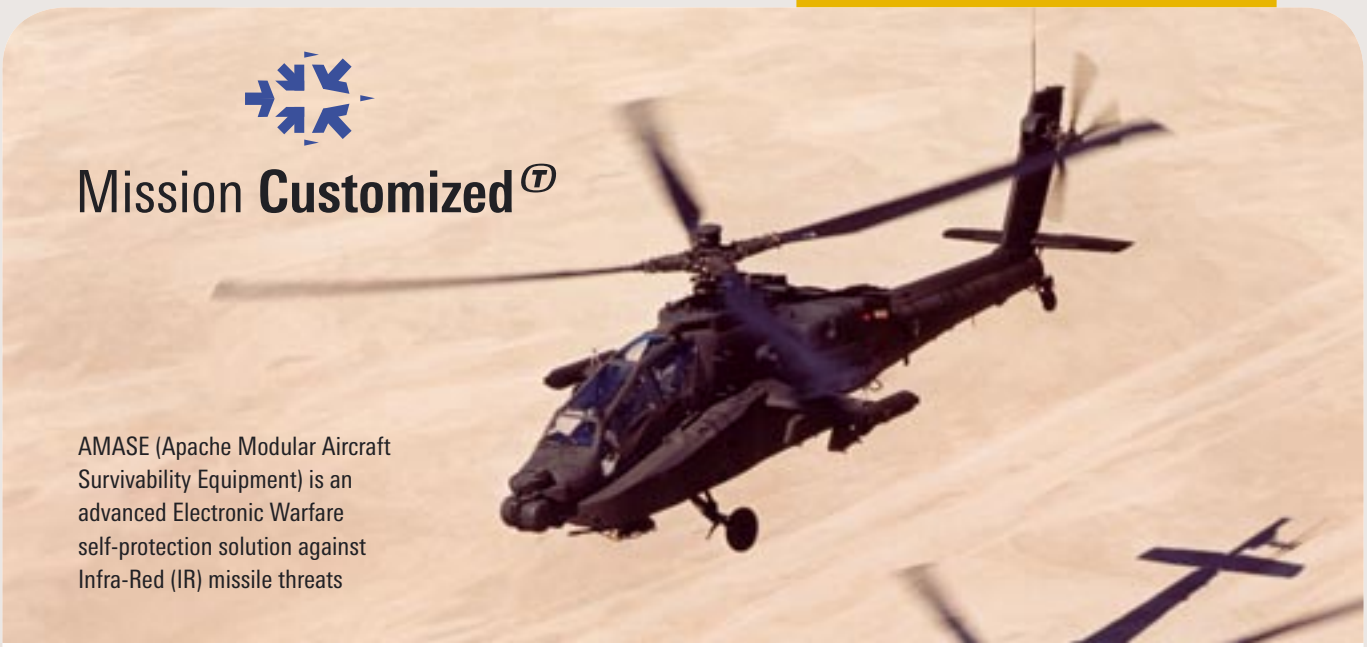
Advanced Threat Display

To further improve the pilot's situational awareness, Terma has been tasked to install a new "Advanced Threat Display" (ATD) in the cockpit. The ATD gives the pilot a total picture of the EW situation on one display, so with one glance on the color display, the pilot can see all RF and IR threats. He can see which threats are being countered, and he can check the status on his EW systems, including Radar Warner, Jammer, Chaff/Flare, and MWS. The display is of course fully night vision goggle compatible.

Concept demonstrators of the systems have been tested in a RDAF F-16 for almost two years. The complete installation will be fully operational in 2008.

The 3D-audio system processes all audio input before it is sent to the pilot

Mission **Customized**



AMASE (Apache Modular Aircraft Survivability Equipment) is an advanced Electronic Warfare self-protection solution against Infra-Red (IR) missile threats

The majority of Terma's business is related to aircraft, being it self-protection systems, reconnaissance systems, advanced aerostructures, or manufacturing services.

Terma has provided more than 1,600 self-protection systems based on our AN/ALQ-213(V) Electronic Warfare Management System (EWMS). We cooperate with aircraft operators to understand their missions and to quickly develop cost-effective solutions which meet their needs. High emphasis is placed on providing pilots with the best possible situational awareness, to automatically initiate countermeasures and hereby establish an efficient self-protection. Our customers benefit from our extensive experience in significant areas:

- Free choice of EW sub-systems – optimized selection to satisfy requirements. The AN/ALQ-213(V) is the only generic EW management system where customers can choose the EW sub-systems according to their needs.
- Minimum modifications to aircraft – resulting in cost-effective solutions. We seek to identify solutions that require a minimum impact on the fleet. Expensive aircraft installations and/or recertifications can often be either avoided or minimized. Our solutions are primarily based on Non-Developmental Items (NDI).
- Commonality across platforms – reducing total cost of ownership. The same EW sub-system may be installed on different aircraft platforms. This results in major logistics cost savings.

The AMASE project exemplifies Terma's ability to provide mission customized solutions.

AMASE

In February 2004, Terma signed a quick reaction contract with the Royal Netherlands Air Force (RNLAF) to supply self-protection equipment for Apache AH-64D helicopters. From contract signing to development, production, and installation, it took only four months. This was primarily possible due to commonality with the already delivered Chinook self-protection system. The Apaches were deployed to (Iraq) in June 2004.

AMASE (Apache Modular Aircraft Survivability Equipment) is an advanced Electronic Warfare self-protection solution against Infra-Red (IR) missile threats. The Stub Wing Pods, placed on the tips of the Apache stub wings on each side of the helicopter, contain the Missile Warning and Flare Dispensing systems. This position of pods has two major advantages: it is an ideal location for missile warning sensors as there is very little shadowing from the aircraft structure and there is no operational restrictions on weapons deployment. In addition, the pods may be shared between helicopters, thus lowering overall costs.

AN/ALQ-213(V) EWMS

The system was originally developed for the Danish Air Force F-16 aircraft in 1992/93. In a number of updated versions, the system was later certified and selected by the USA, Norway, The Netherlands, Belgium, Portugal, Australia, Germany, as well as other countries. It has been deployed on fighters, transport aircraft, and helicopters.

We Have Lowered the Boom on Traditional Headsets

The new and innovative tbone Aviation™ Headset is an ultra-light and comfortable headset for pilots. Weighing less than 10 grams and custom molded to the individual user, the tbone Aviation™ Headset offers perfect comfort, effective reduction of ambient noise, and allows clear communication with crew members, while never compromising situational awareness.

The new and innovative tbone Aviation™ Headset is an ultra-light and comfortable headset for pilots

The tbone Aviation™ Headset is based on Terma's patented bone-conducting technology, a microphone principle that picks up the voice from the jawbone inside the user's ear. It works like a throat microphone, only it is tucked away in the user's ear canal, where it is always situated in the correct position. This concept eliminates the microphone boom completely, providing an extremely compact design with focus on safety and comfort.

Advantages

The headset design has a number of advantages when compared with traditional headsets:

- tbone Aviation™ Headset earpieces are individually "sculptured" and molded to fit the user's ears, ensuring optimal comfort and a perfect hold.
- The headset is convenient to wear, even for lengthy flights, because the pilot avoids the hot-spots associated with other headsets on or around the ear.
- With no microphone boom, no earcups, and no headband, the user can eat and drink while still communicating effortlessly.
- The headset's compact nature allows for ease in putting on and wearing an oxygen mask in critical situations.
- The earplug, by itself, works as hearing protection against loud noises in the cockpit, yet the implementation of special acoustical filters makes it possible to speak with fellow pilots and cabin crew, without removing the headset.
- The headset is moreover unique as it can be worn while performing a walk around inspection and in turn provides the user with effective noise protection.

Critical Solution

The tbone Aviation™ Headset is fully compatible with the oxygen mask. There is no need for removing and re-applying the headset and switching to mask microphone. Just slip on the mask and stay in continuous communication. As the microphone picks up speech sounds from the user's head only, the usual breathing noises from within the mask are eliminated.

The tbone Aviation™ Headset has a number of advantages when compared with traditional headsets

European and U.S. F-16 Customers Order Pylon Upgrades from Terma

The requirement from the European Participating Group (Norway, Denmark, The Netherlands, Belgium, and Portugal) and U.S. Air National Guard / U.S. Air Force Reserves to carry Smart Bombs on their F-16s has resulted in large production orders for the Terma developed pylon upgrades.

After the successful European/U.S. demonstration program of the Terma developed concept for upgrading the Wing Weapon Pylon versions to carry Smart Weapons in 1998, the concept was certified and implemented into the F-16 configuration system. The F-16 SPO sponsored an Engineering Manufacturing Development Program (EMD) that provided full Seek Eagle Office certification and implementation into the Lockheed Martin Aero "Multi Program Release System".

The EMD effort was successfully completed and production contracts have now been received from Norway, Denmark, The Netherlands, Belgium, Portugal, U.S. Air National Guard, and U.S. Air Force Reserves. The total production quantity exceeds 700 units and is valued at more than EUR 34 million. Production is planned to continue until 2009.

The upgraded pylon variants comprise the following:

- Standard Wing Weapon Pylon (SWWP)
- Pylon Integrated Dispenser System, universal (PIDSU)
  – *3 Chaff/Flare dispensers*
- Pylon Integrated Dispenser System w/Missile Warner installed (PIDS+)
  – *2 Chaff/Flare dispensers, 3 MWS sensors & 1 MWS processor*
- Electronic Combat Integrated Pylon System, universal (ECIPSU)
  – *1 ALQ-162 Jammer, antennas forward and aft*

The pylon variants feature a modular design which facilitates future upgrades

- Electronic Combat Integrated Pylon System w/Missile Warner installed (ECIPS+)
  – *1 ALQ-162 Jammer, antennas forward and aft, 3 MWS sensors.*

The pylon variants feature a modular design which facilitates future upgrades. For instance; a PIDSU can be upgraded to a PIDS+ by a Field Upgrade Kit where all the parts to be replaced are interchangeable.
The same concept applies for ECIPSU.

The total production quantity exceeds 700 units and is valued at more than EUR 34 million

F-16 Effectiveness Improvement through Smart Triple Ejector

After having provided the F-16 Wing Weapon Pylons with MIL-STD-1760 (Smart Weapon) capability, it was a logic step for Terma to develop the same capability for the Triple Ejector Rack (TER-9A). In cooperation with the Royal Danish Air Force, Terma is now building prototypes of the "Smart Triple Ejector Rack" (STER) to be tested later this year.

Several F-16 countries are planning to acquire 500 lbs. class Smart Weapons such as GBU-38 (GPS guided Joint Direct Attack Munitions – JDAM) and EGBU-12 GPS/Laser guided Smart Bomb. With the recent Terma upgrade of the F-16 pylons, a similar upgrade of the TER-9 to STER will provide a momentous improvement of the mission effectiveness of the F-16. Rather than carrying two ea. 2000 lbs. Smart Weapons capable of destroying two targets, the F-16 can now carry three + three ea. equal six Smart Weapons capable of destroying six targets, a stunning 300 % mission effectiveness improvement.

On the technical side, the TER-9A upgrade to STER comprise the following:

- retain the aerodynamic envelope of the TER-9A to minimize the certification effort
- retain TER-9A dumb bomb capabilities
- replace all electrical and electronic installations in the rack
- add a new power supply to support 28vDC power quality requirements
- add a new "Router and Digital Sequencer" (RODS) unit
- add new active umbilical cables to secure reliable release of the umbilical cables prior to stores release.

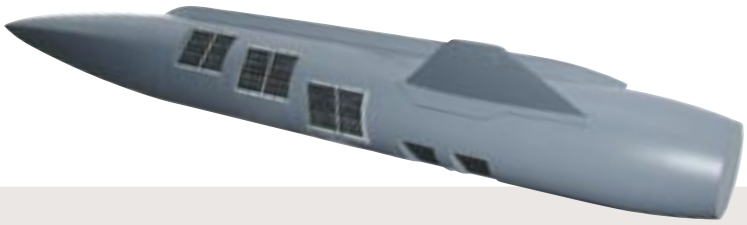
As part of the MLU M5, the EPAF F-16s will receive updates to the Stores Management System program which will allow the F-16 to handle multiple Smart Weapons on the wing stations, so the aircraft update is already planned.

Modular Countermeasures Pod

The Modular Countermeasures Pod was originally developed for The Netherlands Fokker-60 utility aircraft in the mid 1990s.

The MCP is currently in production for the German C-160 program, where their aircraft is being equipped with the MCP-10 (ten Chaff/Flare dispensers and associated electronics). The program is progressing as planned and together with the Scab-on and fuselage mounted dispensers, the German C-160 features a very capable countermeasures installation.

The modular and flexible design makes it easy to install other systems in the pod and several prototype designs have been evaluated for various platforms. One of the very promising variants of the MCP is the MCP-F (Fighter). The MCP-F is designed for fast jets such as Tornado, F-16, etc. In the basic version, the MCP-F accommodates eight Chaff/Flare dispensers and associated electronics, but growth potential includes volume for Towed Decoy, Missile Warner System, Jammer, etc.



On the Leading Edge of Airborne Tactical Reconnaissance

Copyright: Saab

In April 2005, the Modular Reconnaissance Pod System (MRPS) for the Swedish Air Force JAS 39 Gripen fighter made its first flight. Terma's MRPS can be carried on various other aircraft platforms and each pod configuration is tailored to specific customer requirements.

Under contract with prime contractor SaabTech, Terma has developed the round-structured pod for the Swedish Air Force JAS 39 Gripen fighter and supplied the Environmental Control System, the electrical systems, and the main control system - Reconnaissance Management System (RMS).

Maximum Flexibility

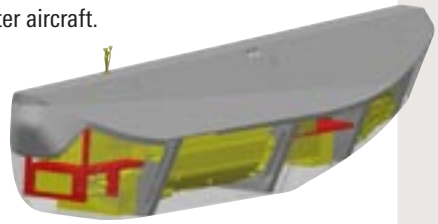
Development of the MRPS started in 2003 and is based on Terma's experiences from the F-16 Modular Reconnaissance Pod (MRP), which is in service in a number of countries in several configurations. The MRPS, the F-16 MRP, and the RMS are of a modular design, enabling a variety of sensors and other payloads and designed to be installed on a standard centerline store, alternatively wing stored.

The MRPS selected by the Swedish Air Force for the Gripen can be carried on various other aircraft platforms and provides a maximum of flexibility in tailoring the sensor suite to operational requirements for airborne tactical reconnaissance. It is easily integrated into the aircraft avionics, and the pod is designed for autonomous operation with the integrated Environmental Control System.

The reconnaissance payload can include a sensor or a combination of sensors and is housed in three main compartments and a rotating window section. The rotating window mid-section can accommodate advanced sensors, suitable for missions at any altitude. The forward and aft compartments can house Data Link components and additional sensors as applicable. Forward and aft radomes are designed to host the Data Link antennas. Layout of sensor suite equipment and configuration support structure and access provisions is specific to each different sensor suite.

Tailored to Specific Customer Requirements

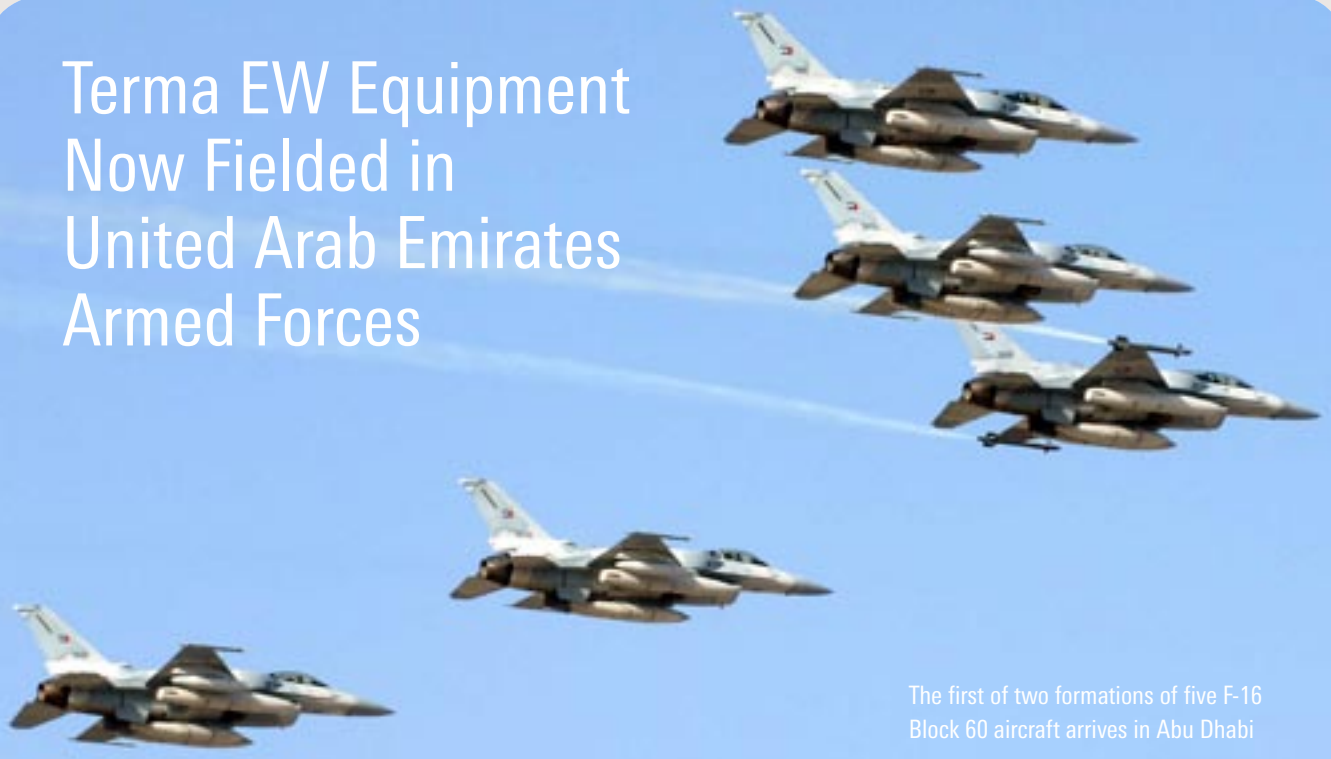
The unique modular design of the Terma pods has proven its existence where customer requirements for high-end sensor technology combined with advanced computing and control of the pod internal environment have been fulfilled in Low-, Medium-, and High-Altitude sensor configurations in the same basic pod structure (regardless of sensor manufacturer). Each pod configuration is tailored to the specific customer requirements and provides the customer with a modular reconnaissance dimension to a modern multi-/swing-role fighter aircraft.



Terma strives to enhance and expand the modular design of our reconnaissance pods in order to satisfy the growing demand for advanced sensor equipment to be operated in the extreme conditions of a fighter environment. Therefore, we maintain a close relationship with customers and leading sensor manufacturers.

With more than 50 MRPs operational in air forces worldwide, Terma takes a lead in providing intelligence information and situational awareness in peace support operations and for the war fighter.

Terma EW Equipment Now Fielded in United Arab Emirates Armed Forces



The first of two formations of five F-16 Block 60 aircraft arrives in Abu Dhabi

On 3 May 2005, The United Arab Emirates (UAE) celebrated arrival of its first Lockheed Martin produced F-16 E/F. During a ceremony in Abu Dhabi, a formation of the first ten F-16 Block 60 aircraft were received by the Supreme Commander of the UAE Armed Forces. This first installment of aircraft was flown in by UAE Air Force pilots who recently completed their F-16 training in the U.S.

The F-16E/F Block 60 - also known as Block 60 "Desert Falcon" - is the latest and most advanced version of the long line of F-16 combat aircraft produced by Lockheed Martin Aeronautic (LMA).

The UAE F-16E/F Block 60 comprises Terma manufactured EW equipment. The AN/ALQ-213(V) EW Management System (EWMS), the Advanced Countermeasures Dispenser System (ACMDS), and the Smart Weapons enhanced version of the Pylon Integrated Dispense System (PIDS-3U) are all baseline components forming part of the Block 60 self-protection suite. As one among just four non-U.S. companies, Terma was awarded the Block 60 contract back in 2000.

The UAE has ordered a total of 80 F-16 aircraft comprising 55 ea. single-seat, F-16E, and 25 ea. two-seat, F-16F. The remaining quantity of aircraft will be delivered in monthly batches of four.

The first flight of the F-16E/F was made in December 2003. Flight testing by Lockheed Martin began in early 2004. This initial delivery marks another important and proud milestone for all team players in this most dedicated program.

Terma AN/ALQ-213 EWMS, shown here in the lower left hand corner, in the F-16 Block 60 cockpit

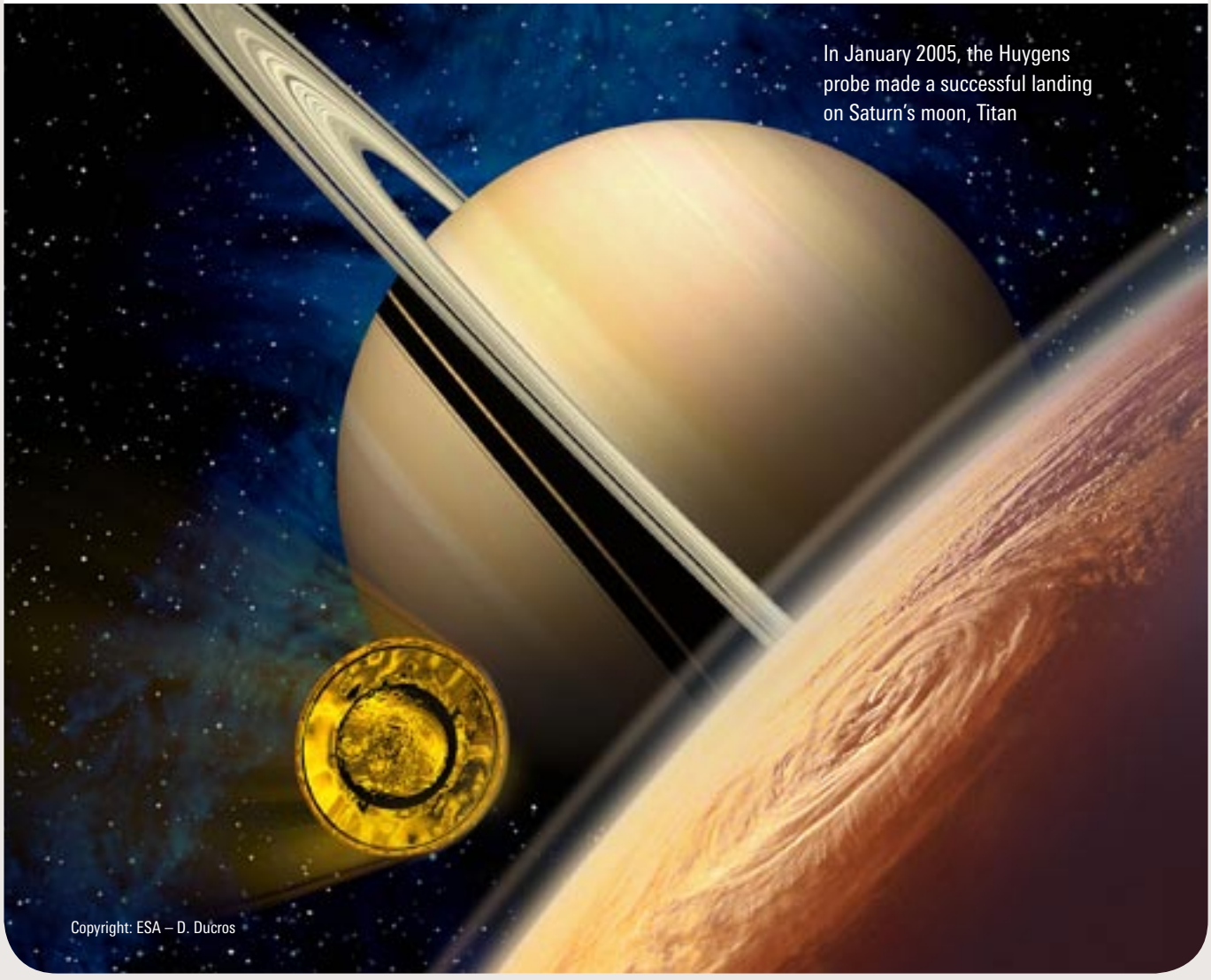
Mission Critical Space Electronics

Terma provided vital electronics for the Huygens probe which this year made a successful landing on Saturn's moon, Titan. The Mars Express orbiter and the Rosetta deep space comet chaser are also dependent on Terma equipment.

January 2005 marked an important event for Terma: the Huygens probe made a successful landing on Saturn's moon, Titan. Precise wakening of the dormant spacecraft for its descent through the foreign atmosphere was the small but indispensable task of Terma's Mission Timer Unit.

Other significant achievements in the past year have been the commissioning of a complete power management system on board the Mars Express orbiter and on the Rosetta deep space comet chaser. Developed specifically for solar system exploration, Terma's Maximum Power Point Tracking facility adapts autonomously to the changing environment of the spacecraft and optimizes the supply of power to the many subsystems on board. The same equipment will fly on Venus Express, to be launched later this year.

A unique feature of Terma's technology is the high power output to mass ratio that is provided which makes it attractive for other missions as well. NASA has asked Terma to provide trade-offs to more specifically describe how this power management concept may have merit also for NASA's planned exploration of the solar system.



In January 2005, the Huygens probe made a successful landing on Saturn's moon, Titan

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Belgian C-130H Updated with Terma AN/ALQ-213(V)

Terma has quite an exceptional record of integrating self-protection systems on transport aircraft. In the early 1990s, Terma integrated self-protection systems on the C-130H for the Royal Danish Air Force (RDAF) and on the C-160 for the German Air Force. Installations on the Dutch and Portuguese C-130H followed later.

Inbound Belgian Defence C-130H

Copyright: Dirk Voortmans

On 11 April 2005, Terma signed a new contract for an update of the self-protection system on board 11 Belgian C-130H transport aircraft. The contract was signed with French company, Thales Airborne Systems, who is the prime contractor and manufacturer of the Radar Warning Receiver (RWR), also included as part of the update.

Self-protection system control and display integrated into a Royal Danish Air Force C-130J-30

State-of-the-Art Functionality

The integration on the Belgian C-130H will reflect a state-of-the-art AN/ALQ-213(V) functionality, making it somewhat different from earlier transport aircraft integrations. The update program will include the latest development in self-protection systems integration. All threat displays and system control will be carried out through one large single Situational Awareness Display. The pilot will benefit from automated track response (Terma ECAP function) and in-flight Embedded Training.

Good and Efficient Cooperation

At all times, Terma's installations have been based on state-of-the-art technology and PVI (pilot-vehicle interface), where RWRs, Jammers, Missile Warning Receivers, and dispenser system were tied together using the AN/ALQ-213(V). The control and display capabilities of earlier integrations were limited to using conventional monochrome displays for RWR identified threats and AN/ALQ-213(V) dot-matrix text displays and panels for control.

In general, the nature of Terma's integration programs focus on a good and efficient cooperation with customers. Through these relationships, Terma has been on the leading edge of user functionality development trends, and has developed the AN/ALQ-213(V) together with the Tactical Data Equipment family; technology which improves situational awareness and track response processing (ECAP). This is reflected in the latest programs in the transport aircraft business.

Late last year, Terma finalized integration of the AN/ALQ-213(V) as self-protection system controller into the glass cockpit of the RDAF C-130J-30; an integration where the AN/ALQ-213(V) and the self-protection system installation is transparent to the pilot. All control and display functions of the self-protection system are accomplished through the use of existing panels and displays.

Future Transport Aircraft Upgrades

The need for military transport aircraft as part of international operations in hostile areas has increased during the last years. The experience of integrating different systems on military aircraft and tailoring a system fulfilling pilot needs, enables Terma to meet future self-protection system integration tasks with leading edge mission customized solutions.

Royal Danish Air Force C-130J-30 dispensing flares (Copyright: RDAF)

Financial Highlights

DKK million	2004/05	2003/04	2002/03	2001/02	2000/01
Sales	1,214	1,096	963	1,017	903
Sales share abroad	976	883	804	593	552
Profit for the year before tax	81	73	60	60	44
Equity Capital, year-end	339	320	309	249	238
Assets, total	1,004	1,131	1,061	933	944
Order intake	1,136	871	1,266	1,076	1,035
Order book, year-end	1,369	1,447	1,672	1,369	1,311
Number of full-time employees – Average for the year	1,034	1,010	945	855	850

Copyright: Dirk Voortmans

We Provide Mission Customized Solutions

Terma develops and markets high-tech solutions, systems, and products for civilian and military applications. Terma A/S headquarters is located at Lystrup near Aarhus, Denmark. Terma is a 100 % Danish owned company.

Terma's high-tech solutions and products are developed and designed for use in extreme mission critical environments and situations, where human lives and valuable material assets are at stake.

Terma's business areas cover:

- Aerostructures for aircraft
- Airborne Systems, incuding
  - Self-protection systems for aircraft
  - Audio systems solutions
  - Reconnaissance systems for fighter aircraft
  - Electronics manufacturing
- Integrated Systems, including
  - Self-protection systems for ships
  - Command and control systems for navy, army, and air force applications
- Radar surveillance systems
- Solutions, services, and products for space applications
- Air traffic management systems
- IT services.

Domestic Terma facilities are located at Lystrup, Grenaa, and Herlev.

Abroad, Terma locations include Leiden, The Netherlands; Besozzo, Italy; Weiterstadt near Frankfurt, Germany; Washington DC, and Warner Robins, GA, USA.

Terma A/S was established in 1949. For many years, Terma has worked closely with defense forces, public authorities, and international organizations around the world. Through these relationships, Terma has gained in-depth knowledge of and insight into our customers' working environment and an equally deep understanding of their situations and needs.

Terma is ultimately owned by the Thomas B. Thrige Foundation.

TERMA UPDATE . JUNE 2005 **Editor** Kasper Rasmussen, kar@terma.com

Terma A/S
Hovmarken 4
8520 Lystrup
Denmark
T +45 8743 6000
F +45 8743 6001

Terma A/S
Fabrikvej 1
8500 Grenaa
Denmark
T +45 8743 6000
F +45 8743 6001

Terma North America Inc.
151 Osigian Blvd, Suite 154
Warner Robins, GA 31088-7810
USA
T +1 (478) 953 3170
F +1 (478) 953 3173

Terma North America Inc.
3200 Whitehaven Street, N.W.
Washington, DC 20008
USA
T +1 (202) 797 5388
F +1 (202) 797 5313

www.terma.com

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